EPAct/EISA Testing Status

CRC Emissions Committee Meeting

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January 14, 2009

EPAct Test Programs

- Light Duty Gas Exhaust Fuels (SwRI)
- Oil Study (NVFEL)
- PM Speciation (ORD NRMRL/NVFEL)
- Nonroad Exhaust (Intertek Carnot)
- E-77-2 evaporative emissions laboratory testing projects
- Percent of High Evap in Fleet, E-77-3 (Colorado/Texas)

Light Duty Gas Exhaust Fuels (SwRI)

- Objective: Phases 1 and 2 are in support RFS 2 and Phase 3 is to establish the effects of RVP, T50, T90, aromatic and EtOH content on exhaust emissions from Tier 2 vehicles
- Collaborating with DOE (NREL)
- Program Design
  - Phase 1 Testing:
    - Testing 75°F over LA92
    - 3 'typical' fuels E0, E10, and E15
    - 19 high sales volume Tier 2, 2 high-emitter and 1 high mileage NLEV vehicles
    - Testing complete for first 19 vehicles
  - Phase 2: Repeat of Phase 1 except at 50°F
    - Testing complete for Fuel 17
    - Testing finishing this week for Fuel 18
    - Should be complete with testing for Fuel 19 by 2nd week of Feb 2009
  - Phase 3: Main Program
    - 27 fuels tested in 19 Tier 2 vehicles, E85 tested in 4 FFVs that are included in the 19
    - Fuel Matrix, 5 variables in matrix
      - Revised matrix goes from 5 E15/4 E20 fuels -> 3 E15/6 E20 fuels to streamline the blending process

Phase 3 Status

- 27 Fuels:
  - All recipes have been sent to SwRI/Halterman
  - 12 fuels in hand blend phase
  - 8 fuels in bulk blend phase
  - 7 fuels delivered to SwRI
- E85 fuel provided by CRC
  - To be shipped from Sarnia, Ontario
- Testing to begin by mid-February

EPAct Fuel Matrix

Phase 3
Base Program (EPA)
(Fuels 1-16) →

Phases 1 and 2
RFS 2 Subset (EPA/DOE)
(Fuels 17-19) →

Phase 3
Additional Fuels
(DOE)
(Fuels 20-29) →

E85 (DOE) →

CRC Additional Fuels

Fuel #	T50 °F	T90 °F	ETOH %	RVP psi	ARO %
1	150	300	10	10	15
2	240	340	0	10	15
3	220	300	10	7	15
4	220	340	10	10	15
5	240	300	0	7	40
6	190	340	10	7	15
7	190	300	0	7	15
8	220	300	0	10	15
9	190	340	0	10	40
10	220	340	10	7	40
11	190	300	10	10	40
12	150	340	10	10	40
13	220	340	0	7	40
14	190	340	0	7	15
15	190	300	0	10	40
16	220	300	10	7	40
17	215	325	0	9	30
18	202	325	10	9	25
19	195	325	15	9	23
20	160	300	20	7	15
21	160	300	20	7	40
22	160	300	20	10	15
23	160	340	20	7	15
24	160	340	20	10	15
25	160	340	20	10	40
26	150	340	15	10	40
27	190	340	15	7	15
28	190	300	15	7	40
29	TBD	TBD	85	TBD	TBD
30	150	325	10	10	40
31	160	325	20	10	15

Revised Fuels

Light Duty Exhaust Fuels (SwRI) Updated Testing Schedule

Phase	Duration	
Fuel blending	February 2008	Early 2009
Phase 1	April 2008	August 2008
Phase 2	November 2008	February 2009
Phase 3	February 2009	December 2009
Reporting	December 2009	March 2010

Fresh Oil PM Study (NVFEL) Program Status

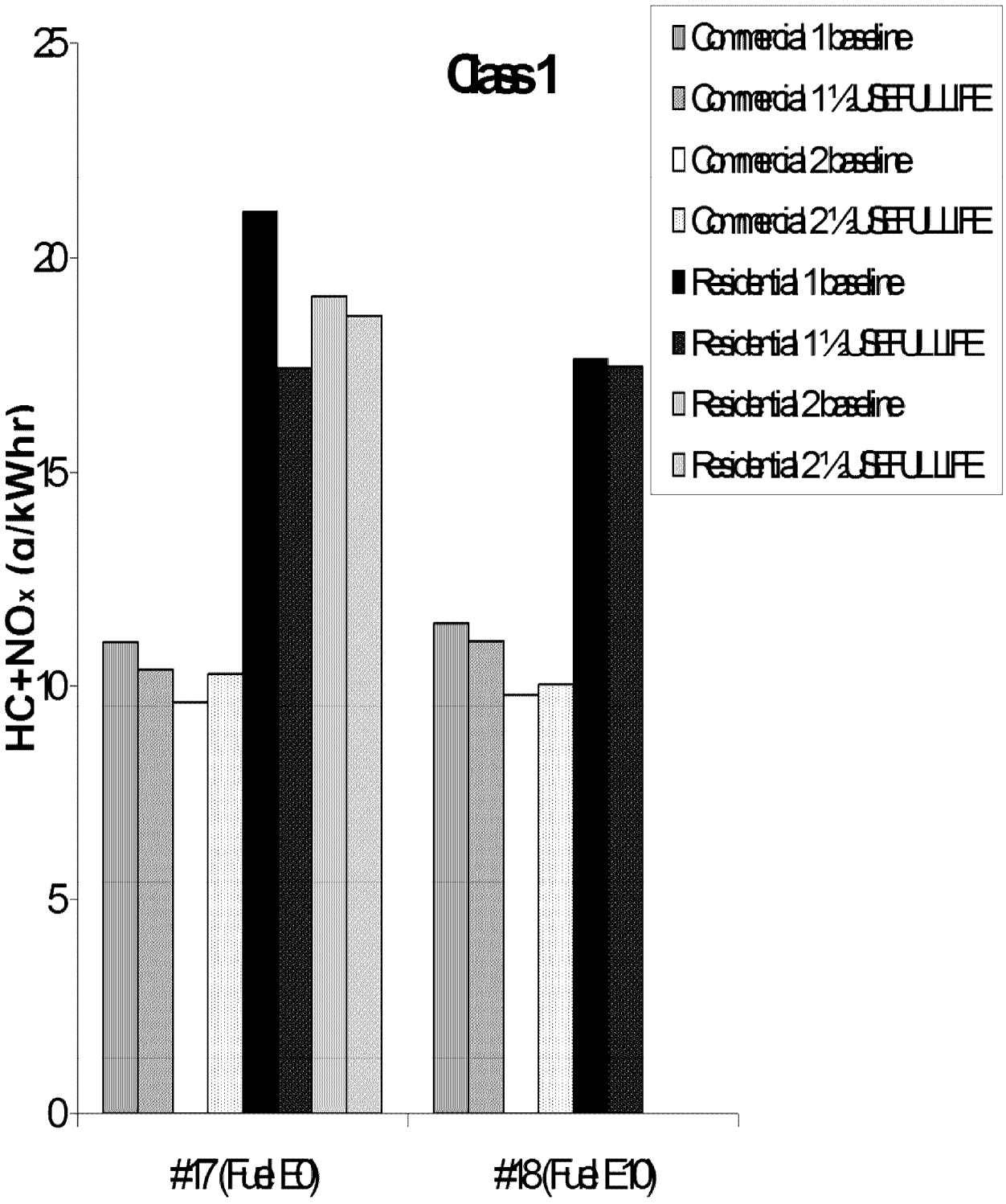
- Oil PM stabilization on E0, E10 and E20 completed
  - EPAct Phase 1 oil aging (2k) “safe” from fresh oil influences on PM
  - Conclusion: Stabilization occurs much lower mileage (.5k to 1k)
    - Likely oil time at temp relationship
    - Did not isolate to PCV (off-gassing) or cylinder surface (oil shearing)
- Abstract submitted to present results at CRC Emissions Workshop in San Diego, March 2009

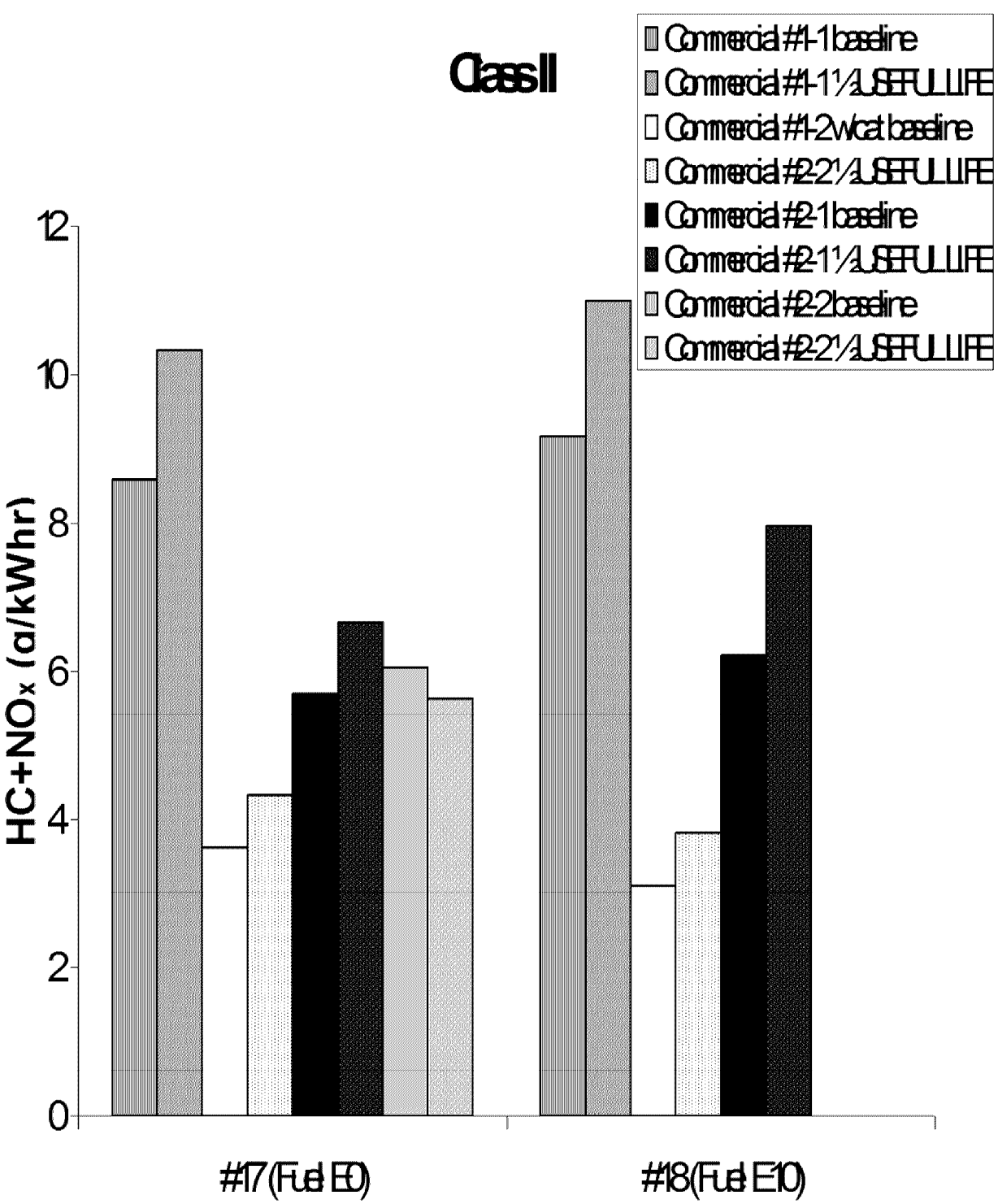
PM Speciation
(NVFEL/ORD-NRMRL)

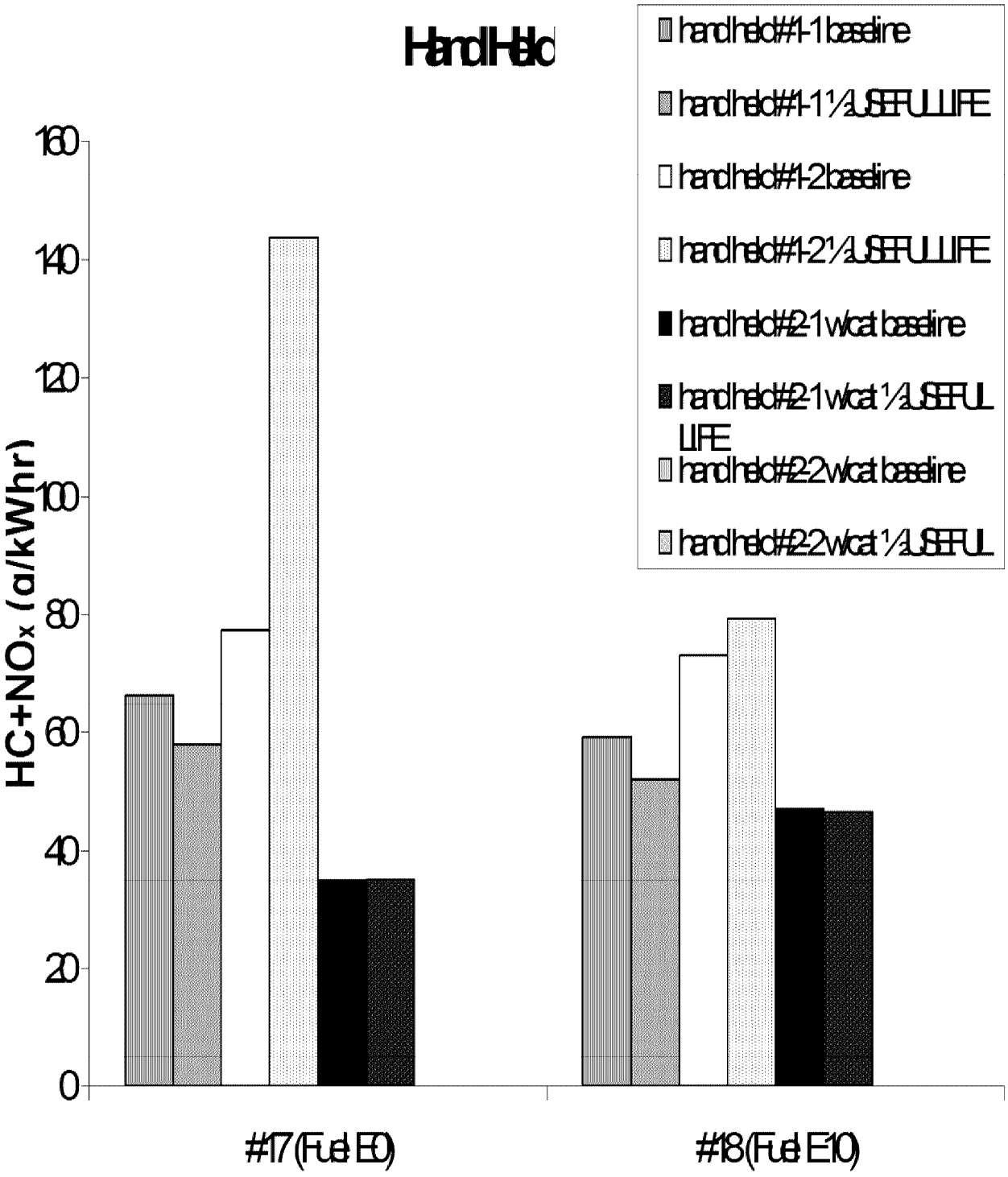
- Objective: To determine fuel effects on PM mass, size and composition, and obtain speciated semi-volatile VOC, metals and ions, and gaseous VOC (MSATs), alcohols and carbonyls.
- Program Design
  - E0, E10 and E85 fuels
  - 3 vehicles (+/-) similar to SwRI vehicles but not necessarily identical (1 non-FFV)
  - 75F and 20F
- Oil-PM Pilot study will help determine PM metals detection limits (secondary experiment)
- Time Line: mid 2009
- In process of designing a Round Robin Program split between NVFEL and ORD-NRMRL

Nonroad Exhaust (Intertek Carnot)

- Objective: Test 6 pairs of small SI engines < 25 hp
  (2 Class 1, 2 Class 2, and 2 Class 4) on 3 fuels (national average E0 (Fuel 17 from fuel matrix), an E10 (Fuel 18 from fuel matrix), and Certification fuel (Indolene))
- Fuels and Aging
  - 2 engines of each engine model
  - One aged on E0 (Fuel 17)
  - One aged on E10 (Fuel 18)
- Emission Test Sequence
  - Baseline: Age each engine for 10 hours and perform 3 emission tests on each fuel (Fuel 17, Fuel 18, and Cert fuel)
  - Aging: Age engine to half life and repeat all emission tests
- Addition:
  - Full life aging for 2 handheld engines (1 on E0, 1 on E10)
- Timeline: Complete by end of January 2009 with report


Class 1
HC+NOx (g/kWhr)
25
20
15
10
5
0
#17 (Fuel E0)
#18 (Fuel E10)
Commercial 1 baseline
Commercial 1½ USEFUL LIFE
Commercial 2 baseline
Commercial 2½ USEFUL LIFE
Residential 1 baseline
Residential 1½ USEFUL LIFE
Residential 2 baseline
Residential 2½ USEFUL LIFE


Class II
Commercial #1-1 baseline
Commercial #1-1 1¼ USEFUL LIFE
Commercial #1-2 w/cat baseline
Commercial #2-2 1¼ USEFUL LIFE
Commercial #2-1 baseline
Commercial #2-1 1¼ USEFUL LIFE
Commercial #2-2 baseline
Commercial #2-2 1¼ USEFUL LIFE
HC+NOx (g/kWhr)
0
2
4
6
8
10
12
#17 (Fuel E0)
#18 (Fuel E10)


HandHeld
handheld#1-1baseline
handheld#1-1½USEFULLIFE
handheld#1-2baseline
handheld#1-2½USEFULLIFE
handheld#2-1w/catbaseline
handheld#2-1w/cat½USEFUL LIFE
handheld#2-2w/catbaseline
handheld#2-2w/cat½USEFUL
HC+NOx (g/kWhr)
160
140
120
100
80
60
40
20
0
#17(Fuel E0)
#18(Fuel E10)

New Nonroad Program - SwRI

- Objective: Supplement ongoing nonroad ethanol test programs by ARB and EPA on nonroad applications.
  - Collect exhaust emission data (primary, alcohols, N2O, speciation, etc.) on federal test fuel, ARB E10 fuel and an ARB E10 boost to 10psi fuel.

- Engines/applications chosen:
  - Two new 2 stroke motorcycles
  - Two used 2 stroke motorcycles
  - Two used ATV's, *found*
  - One large SI engine with c
  - Two Sterndrive/Inboard marine engines (from ARB)
  - 9 small SI engines < 25 hp (from ARB)

Pending, still looking for;
Require unmodified for program

- New/As-is engine condition and certification cycle testing only (no durability or real world aging).

- Timing: Completed by June 2009
- Status: Just started SI engine testing last week

Evaporative Testing E-77-2 (ATL)

- Program Design
  - Vehicles
    - 8 Tier 2/Near Zero
    - 2 implanted leaks
  - Fuels
    - E0, 7 and 9 psi
    - E10, 7 and 10 psi
    - E20, 9 psi funded by DOE
  - Test Plan, after 4 weeks preconditioning at each ethanol level:
    - Static permeation
    - Running loss
    - Hot soak
    - 72 hour diurnal (65^{o}-105^{o}F)
  - Status: Complete, waiting for report

Evaporative Testing E-77-2b (thru SwRI)

- *Objective*: Additional, newer technology, high sales volume vehicles to the CRC E-77-2
- Plan to repeat E-77-2 program with 8 more vehicles:
  - Add Static test at 105°F
  - Speciation on 100+ VOCs
- SwRI, sub-contracting with HH&A, testing at ATL (complete end of 2009)
- CRC will supply fuel which was left over from E-74b and E-77-2 programs for continuity
- Vehicles:
  - CRC to supply 5 vehicles from E-74b program
  - 3 additional vehicles:
    - 1 PZEV
    - 2 MY 2000 enhanced evap

E-77-2b Fleet Composition

Updated 11.19.08

Veh No.	Yr	Make	Model	Odo.	Evap Family	Evap Standards (all are ORVR)	Fuel Tank Tank Size	Fuel Tank Plastic Metal
220	2000	Chevrolet	Malibu			Tier 1		
221	2000	Mitsubishi	Eclispe			Tier1		
206	2002	Nissan	Altima	110,399	2NSXR0120RCB	Tier 1	20.0	Plastic
208	2002	Chevrolet	Trailblazer	60,233	2GMXR0175922	Tier 1	18.6	Plastic
209	2004	Chrysler	Stratus	63,778	4CRXR0130GBA	Tier 1	16.0	Plastic
210	2004	Chevrolet	Impala	63,157	4GMXR0124919	Near Zero	17.0	Plastic
213	2004	Dodge	Ram 1500	99,372	4CRXR0218GDH	Near Zero	35.0	Plastic
222	2004	Nissan	Altima			Zero Evap		

Evaporative Testing E-77-2c

- CRC/NREL additional funds
- Adding E20 7 and 9 psi to E-77-2b vehicles
- Adding E20 7 psi to E-77-2 vehicles - *Pending Approval*
- CRC has approved proposal generated at July E-77 Data Review meeting at NVFEL:
  - Implant leaks on vehicles 207 and 211 (same as previous implants)
    - Two leak mechanisms:
      - Top of fuel tank
      - At hose connecting to canister connection
  - For one Near Zero and one Enhanced vehicle go through Dynamic Permeation Test Procedure:
    - At two temperatures (different from 86°F previously)
      - 65 or 70°F
      - 95°F
    - For 5 fuels in current program (E0 7 and 9 psi, E10 7 and 10 psi, and E20 9 psi)

Determine Fraction of High Evaporative Emissions Vehicles in Fleet, E-77-3 (ERG)

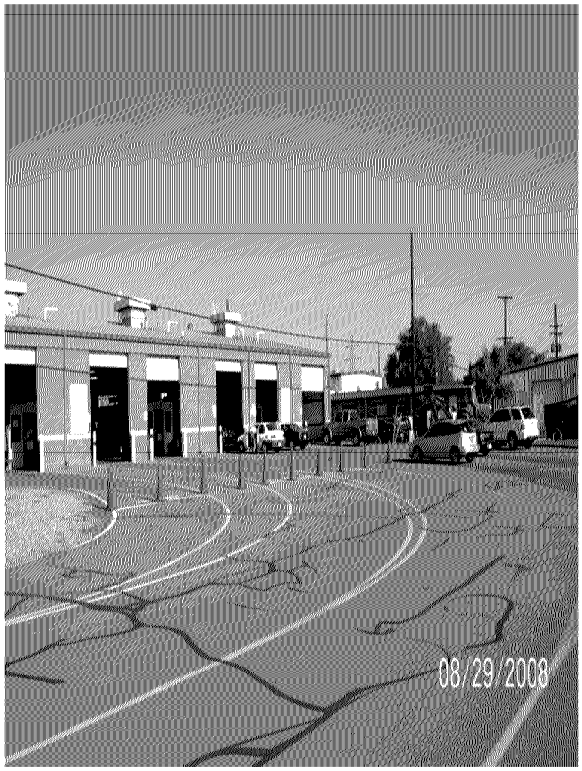
- *Objective*: Find the percentage of high emitting evaporative emission vehicles in the average fleet of on-road motor vehicle passenger cars and light trucks.
- Pilot Program: propose and refine test procedure (Colorado)
  - 50-100 vehicles
  - Pre-screen using RSD
  - Evaluate several methods including portable SHED
- Main Program (Texas)
  - Do measurements on ~1000 vehicles
  - Apply protocols developed in pilot
- ICR
  - Specific to this project
  - Received approval for Pilot only
  - Will resubmit for larger program when plan is complete
- Collaboration
  - Colorado Department of Public Health and Environment (CDPHE)
    - Offering RSD and technical expertise
    - CRADA
  - CRC

Denver Pilot Summer 2008 I/M Area

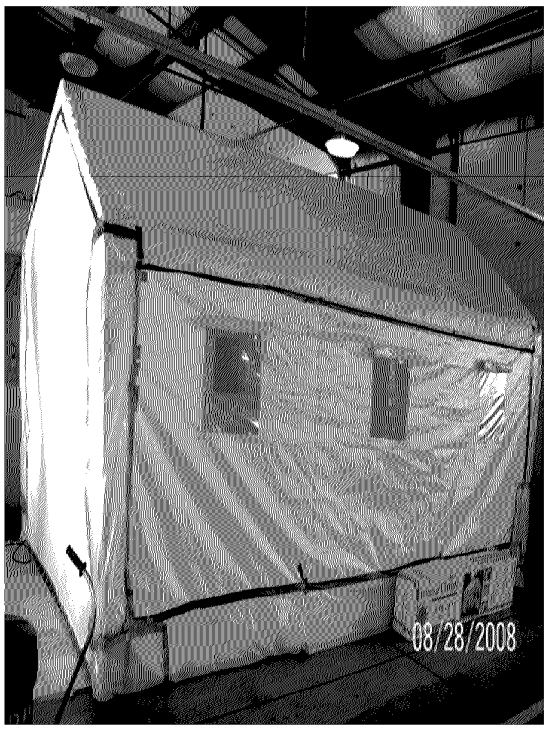
- RSD Investigation – 1st two weeks in field:
  - Verified efficacy of using RSD on simulated fleet
    - CDPHE preliminary work in 2007
    - Optimized the use of RSD for initial screening for Evap
    - Methodology
      - RSD 3000 vs 4000 technology upgrade, now sees both exhaust and evap HC – using in tandem sees high evap
- Recruited 87 vehicles for measurement – 4 weeks in field
  - Sampling method: Probability Proportional to RSD
- Measurement Methods:
  - Modified CA Leak check meth
  - Hand wand check with Sierra monitor

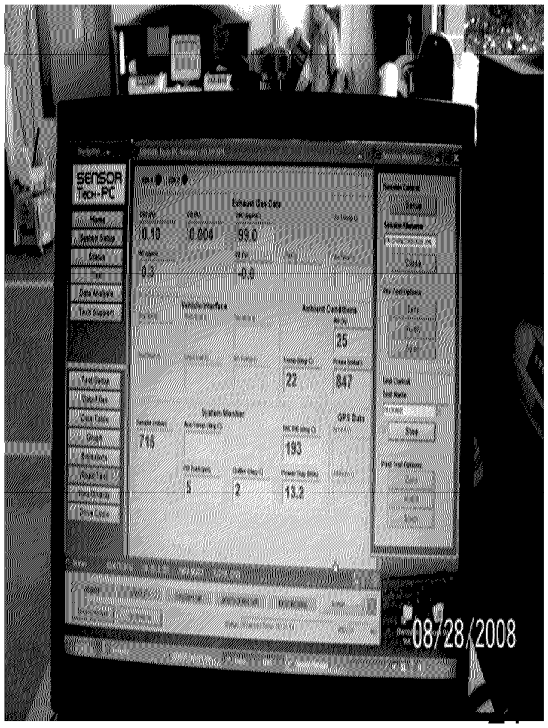
  - IR Camera (*not viable, sent it back after 2 weeks*)
  - Portable SHED (PSHED) for quick Hot Soak (15 min)

Denver Pilot: Entry to Lipan Station, RSD Screen, Solicitation area



Denver Pilot: PSHED





E-77-3 Summary of Pilot

Vehicles Solicited	301
Eligible Vehicles	196
PSHEDs	87
Acceptance Rates	28.9%/44.4%
Lab SHEDs	23

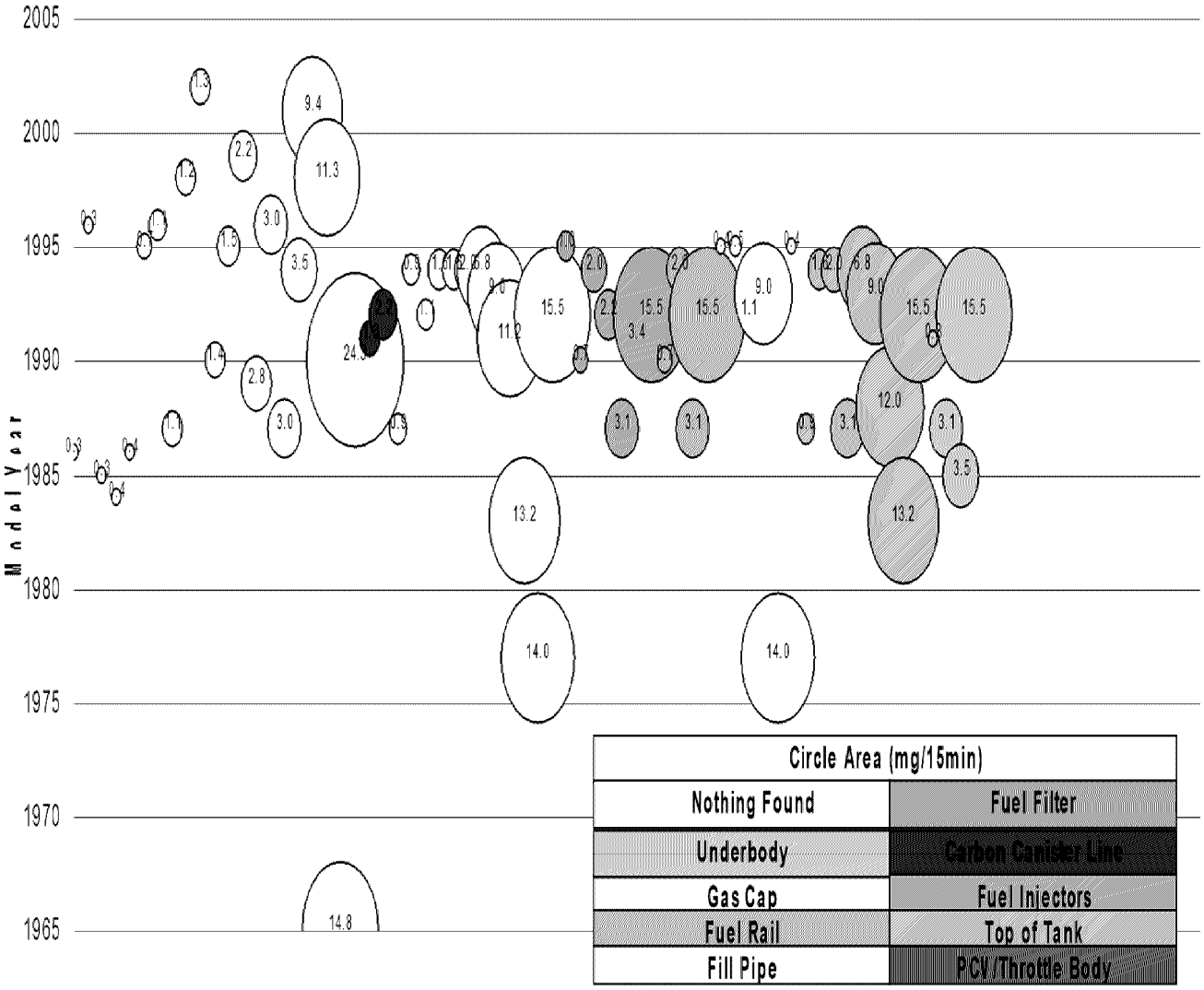
Preliminary Results Summary

45 “leaking”* vehicles out of 87:

Leak Mechanisms	Number of Vehicles
Fill neck	12
Top of tank	10
Fuel injector	6
Fuel rail	4
Canister connections	3-6 (3 “underbody” could be hoses to canister)
Under body	4
Fuel cap	5
Significant leaks, undetermined source	21

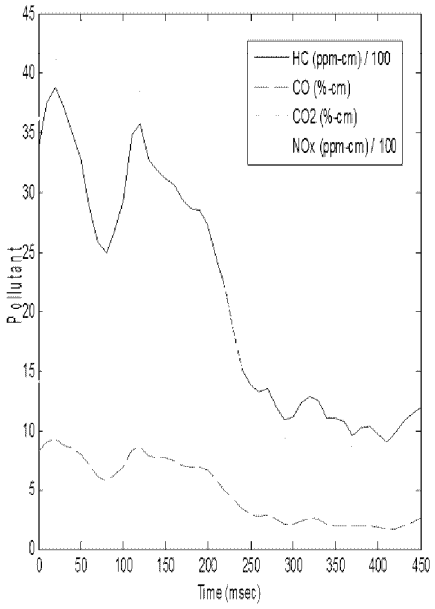
* “leaking” defined as > .3 g/15 min, if assume 20% of std is attributable to hot s
(std of 2 g/test), and 75% occurs in 1st 15 min

Portable SHED Measurements (>.3g)

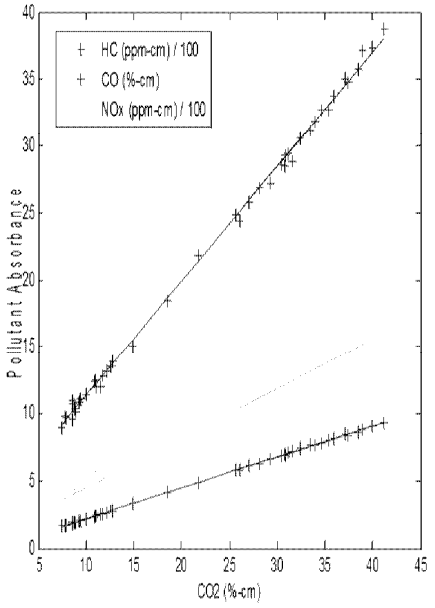


Low Evap Vehicle: All tailpipe species disperse simila

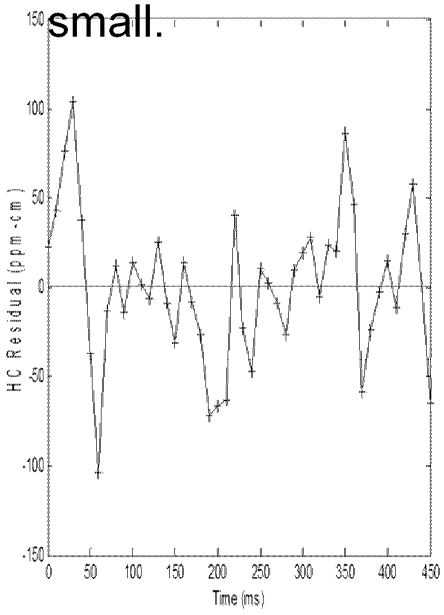
ERG and Subcontractors have developed an algorithm using RSD 4000 alone: RSD Evap Index checks the difference in HC and CO_2 dispersion.



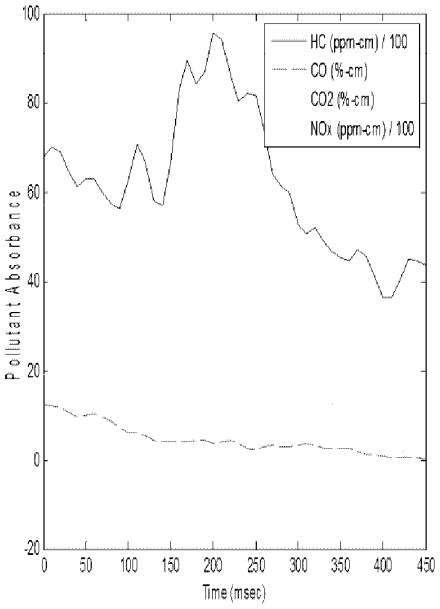
Low Evap Vehicle: HC is linear with tailpipe CO_2.



Low Evap Vehicle: HC vs CO_2 residuals are small.

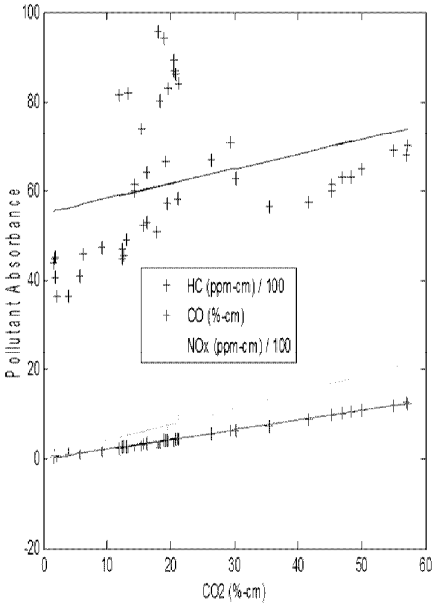


High Evap Vehicle: HC trend different from tailpipe s

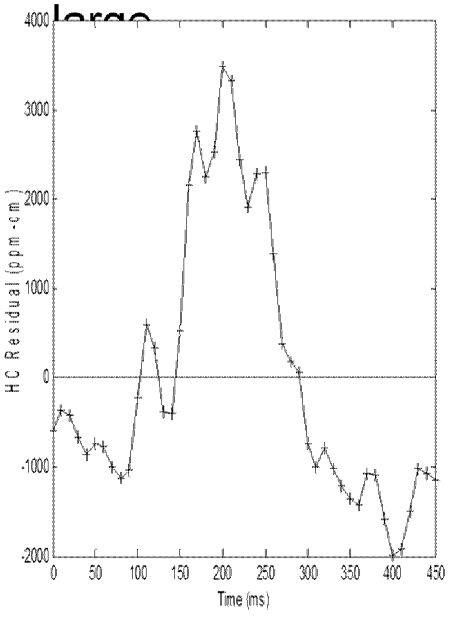


ERG and Subcontractors have developed an algorithm using RSD 4000 alone: RSD Evap Index checks the difference in HC and CO_2 dispersion.

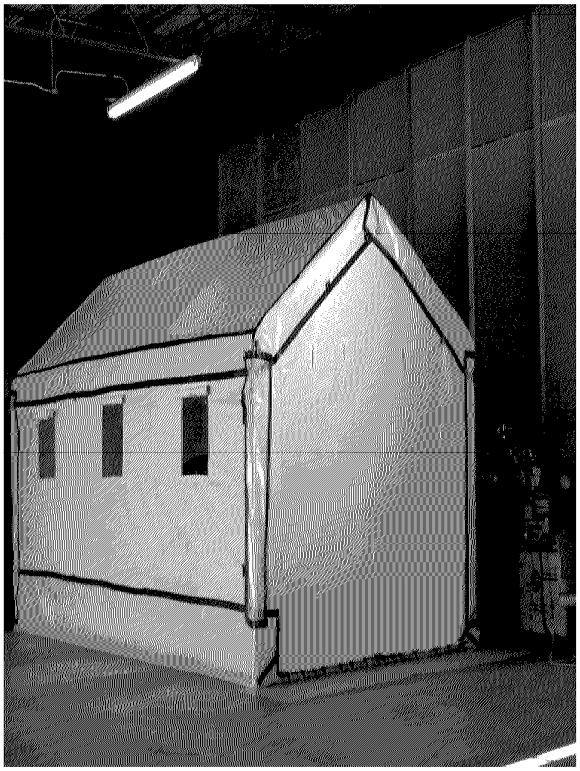
High Evap Vehicle: HC is scattered vs tailpipe CO_2.

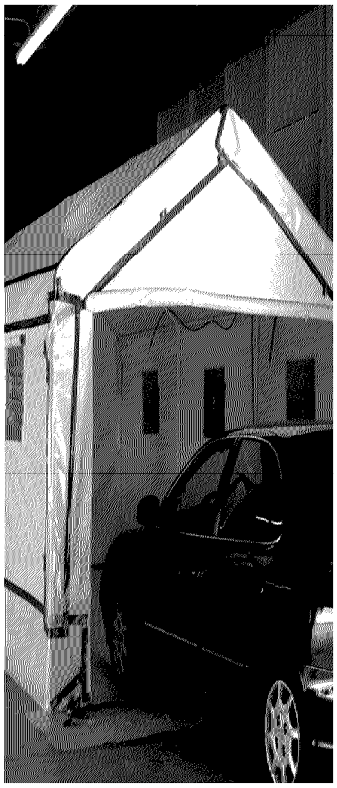


High Evap Vehicle: HC vs CO_2 residuals are large



San Antonio Pilot: Rented Warehouse on La Colonia; RSD Screen, PSHED





Preliminary Findings

- RSD Evap Index
  - Connects RSD and PSHED Evap HC
  - Independent of tailpipe HC
- Ability of RSD to detect High Evaps?
  - One hit detects really high evap emitters
  - Multiple hits probably needed to detect moderately high evap emitters

Larger Program in Spring/Summer 2009

- ***Powerful tool*** for estimating evap emission inventories
  - Preliminary analysis shows we are finding high evap emitters
- Continue our analysis over the next 4-6 weeks
- Need to start planning for the larger program
  - Need ICR approval for larger program
- Need Funding
  - Cost effective, overhead was in pilots
    - ~$1000 for each vehicle, so roughly 300 vehicles for $300K. Bigger bang for buck.

Larger Program in Spring

- At end of the 2nd pilot we will develop a plan for a larger study in Spring of 2009
  - Need ICR approval for larger program
  - Do measurements on 250-500 vehicles
  - Apply protocols developed in pilot
  - Cost effective, overhead was in pilots
    - ~$1000 for each vehicle, so roughly 300 vehicles for $300K. Bigger bang for buck.
  - Out of budget, looking for funds